

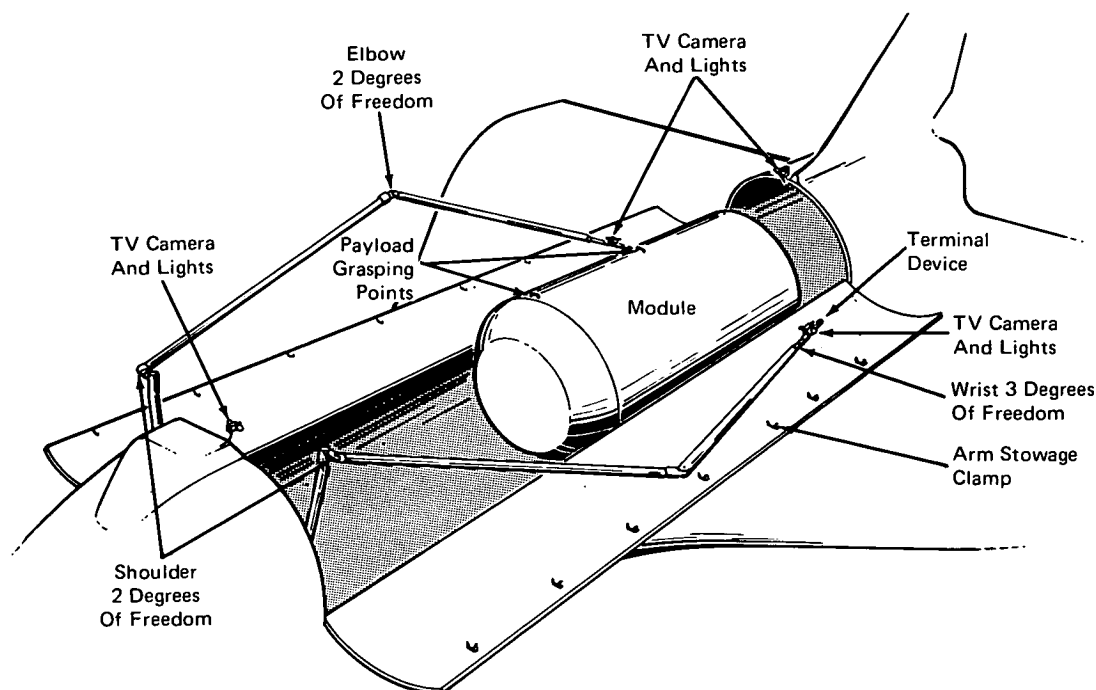
# NASA TECH BRIEF

## *Manned Spacecraft Center*



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### A Proposed Remote Manipulator System: A Concept



In recent years, remotely operated mechanical arms have become an object of interest to many industries involved in some phase of routine production or assembly. Ideally these arms should perform a wide variety of tasks, require little operator training, and be adaptable to automatic control.

A manipulator control system, proposed for use on the space shuttle, meets these requirements and has many features that would be of interest in several applications. The system has a variable ratio, mixed mode, bilateral, master-slave control. The arms (shown in the figure as proposed for a space shuttle) consist of a shoulder with two degrees of freedom, an elbow with two degrees of freedom, a wrist with three degrees of

freedom, and a terminal grasping device. An operator can be readily trained to use the geometrically similar master control that allows parallel control of all the degrees of freedom. Feedback is provided by TV cameras attached near the shoulder, near the terminal grasping device, and at the end of the shuttle opposite the arm.

The system has several features that allow it to efficiently perform a wide range of tasks.

A low sensitivity mode provides a one-to-one ratio between angular movements of the master and the slave. This mode is suitable for moving a load over large distances and for other operations which do not require precise coordination.

(continued overleaf)

A high sensitivity mode has an eighteen-to-one ratio of angular motion between the master and the mechanical system. This high ratio provides a degree of control accurate enough to allow an operator to perform delicate and exact manipulations without extensive practice.

The system is provided with positional and coordinate indexing. At the high master-to-slave angular ratio, more than the full range of movement on the master control may be required to achieve the desired motion by the slave arm. If the master control has reached the end of its play, the slave arm may be position indexed, or held in position, while the master control is returned to the other extreme position from which further motion can be directed. Coordinate indexing maintains geometrically parallel control upon switching the camera used for feedback. In addition, coordinate indexing can be used to operate the arm in direct relation to some device or operation as may be required in an automated process.

Finally, the system may be programed to automatically perform predetermined tasks such as those that are often required on assembly lines.

**Note:**

Requests for further information may be directed to:  
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**Patent status:**

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